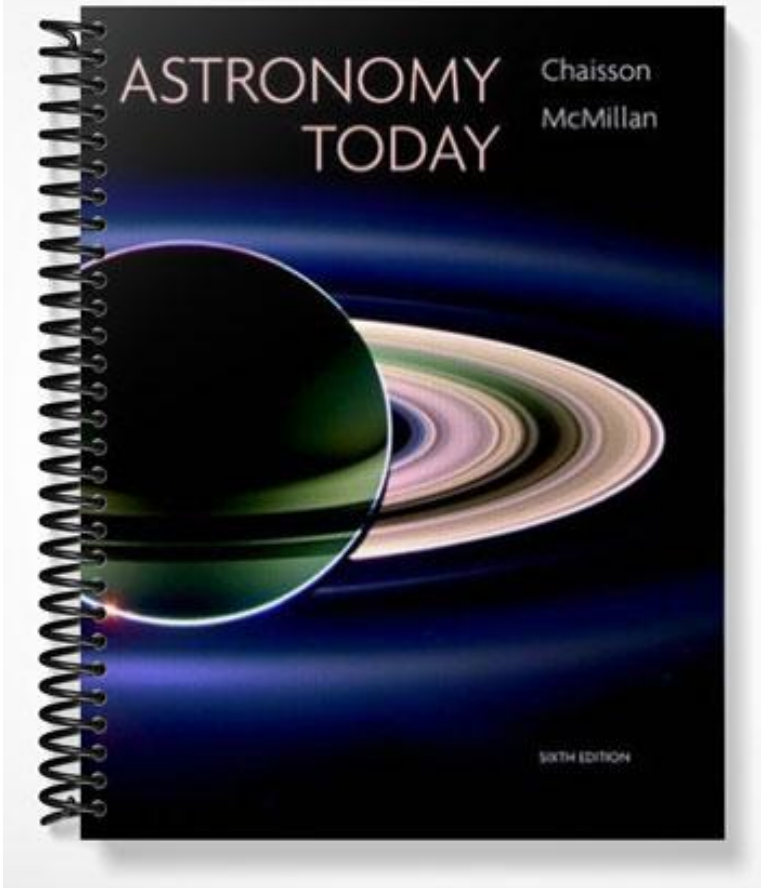
TEST BANK



Astronomy Today, 6e (Chaisson/McMillan)
Chapter 2 The Copernican Revolution: The Birth of Modern Science

2.1 True/False

1) It was the Chinese who provided critical ancient data on supernovae and comets.
Answer: TRUE
Diff: 1 *Page Ref: 2.1*

2) When a planet retrogrades, it appears to move westward for weeks at a time.
Answer: TRUE
Diff: 1 *Page Ref: 2.2*

3) Like the Sun and the Moon, the planets appear to move from west to east from one day to the next.
Answer: TRUE
Diff: 2 *Page Ref: 2.2*

4) Like the Sun and the Moon, the stars appear to move from west to east from one day to the next.
Answer: TRUE
Diff: 2 *Page Ref: 2.2*

5) As originally stated, the Copernican model did no better a job of predicting planetary behavior than did the Ptolemaic one.
Answer: TRUE
Diff: 2 *Page Ref: 2.3*

6) Galileo's observations of the entire phase cycle of Venus proved that Ptolemy's epicycles could not be correct in keeping Venus between us and the Sun.
Answer: TRUE
Diff: 1 *Page Ref: 2.4*

7) Galileo's observations of sunspots proved the Sun was rotating, like the Earth.
Answer: TRUE
Diff: 2 *Page Ref: 2.4*

8) Kepler found the orbits of planets are ellipses, not circles.
Answer: TRUE
Diff: 1 *Page Ref: 2.5*

9) The orbits of most of the planets have eccentricities close to zero.
Answer: TRUE
Diff: 1 *Page Ref: 2.5*

10) Kepler based his theories on the precise planetary observations of Tycho Brahe.
Answer: TRUE
Diff: 1 *Page Ref: 2.5*

11) The eccentricity of a perfectly circular orbit is 1.
Answer: FALSE
Diff: 2 *Page Ref: 2.5*

12) Kepler determined the shape of each planet's orbit by triangulation from different points on Earth's orbit, using observations made at many different times of the year.
Answer: TRUE
Diff: 2 *Page Ref: 2.5*

13) Mercury, with a higher eccentricity orbit, should change its orbital speed more than do Venus or Earth.
Answer: TRUE
Diff: 2 *Page Ref: 2.5*

14) A planet (or comet) will speed up as it approaches the Sun
Answer: TRUE
Diff: 2 *Page Ref: 2.5*

15) Transits of Venus were critical in early determinations of the A.U.
Answer: TRUE
Diff: 2 *Page Ref: 2.5*

16) Newton's Laws completely replaced the incorrect work of Kepler.
Answer: FALSE
Diff: 2 *Page Ref: 2.5*

17) Newton's modification of Kepler's Third Law lets us measure the mass of the Sun.
Answer: TRUE
Diff: 2 *Page Ref: 2.5*

18) Newton's gravity would explain why Saturn, so far from the Sun, moves so slowly across the sky.
Answer: TRUE
Diff: 2 *Page Ref: 2.7*

19) It the mass of a body were doubled, its gravity would become 4X stronger.
Answer: FALSE
Diff: 2 *Page Ref: 2.7*

20) According to Newton's second law, if you double the force acting on a body, the acceleration will double.
Answer: TRUE
Diff: 2 *Page Ref: 2.7*

2.2 Multiple Choice

1) The principal culture that transferred Greek astronomical knowledge to Renaissance Europe was:
   A) Byzantine.
   B) Chinese.
   C) Mongol.
   D) Islamic.
   E) Mayan.
Answer: D
Diff: 1 *Page Ref: 2.2*

2) The most accurate Greek attempt to explain planetary motion was the model of:
A) Aristotle.
B) Pythagoras.
C) Hipparchus.
D) Ptolemy.
E) Erastothenes.
Answer: D
Diff: 1 *Page Ref: 2.2*

3) The Ptolemaic model probably persisted for all these reasons EXCEPT:
A) it had the authority of Aristotle behind it.
B) it was consistent with the doctrines of the Catholic Church.
C) it used perfect circles, which appealed to geometry.
D) it accounted well for Galileo's observations of the phase cycle of Venus.
E) it explain why stellar parallax was not observed by the Greeks.
Answer: D
Diff: 1 *Page Ref: 2.2*

4) The greatest contribution of the Greeks to modern thought was:
A) the idea that all the planets orbited the Sun.
B) that their mythology was the basis for the naming of the constellations.
C) that their observation of stellar parallax proved the Earth orbited the Sun.
D) the development of scientific inquiry and model building.
E) the invention of the telescope.
Answer: D
Diff: 1 *Page Ref: 2.2*

5) The Ptolemaic model of the universe:
A) explained and predicted the motions of the planets with deferents and epicycles.
B) is the basis of our modern cosmology.
C) could not account for the stellar parallax observed by Hipparchus.
D) describes the orbits of the planets as being ellipses, not circles.
E) always kept Mars and Mercury between the Earth and Sun.
Answer: A
Diff: 2 *Page Ref: 2.2*

6) Scientists today do not accept the Ptolemaic model because:
A) it is ancient history.
B) it was too complicated, compared to Copernicus' heliocentric model.
C) it has been shown that Ptolemy faked his data.
D) it had no explanation for retrograde motion.
E) the work of Tycho and Kepler showed the heliocentric model was more accurate.
Answer: E
Diff: 1 *Page Ref: 2.3*

7) On which of these assumptions do Ptolemy and Copernicus agree?
A) The Earth must be the center of all motion in the Cosmos.
B) All orbits must be perfect circles.
C) The Sun was bigger than the Earth.
D) Venus must always stay between us and the Sun.
E) The Sun must orbit us, but the planets do orbit the Sun.
Answer: B
Diff: 1 *Page Ref: 2.3*

8) The heliocentric model was actually first proposed by:
A) Aristotle.
B) Archimedes.
C) Aristarchus.
D) Alexander the Great.
E) Hipparchus.
Answer: C
Diff: 2 *Page Ref: 2.3*

9) According to Copernicus, the retrograde motion for Mars must occur
A) at inferior conjunction, when Mars laps the earth and passes between us and the Sun.
B) at superior conjunction, when Mars lies on the far side of the Sun.
C) at quadrature, when Mars lies exactly 90 degrees east or west of the Sun.
D) at greatest elongation, when Mars can get up to 47 degrees from the Sun.
E) at opposition, when the earth overtakes Mars and passes between Mars and the Sun.
Answer: E
Diff: 2 *Page Ref: 2.3*

10) Which was a contribution to astronomy made by Copernicus?
A) The planets move around the Sun in elliptical orbits.
B) His theory of gravity accounted for the variable speeds of the planets.
C) He laid out the order and relative motion of the known solar system.
D) He discovered the Sun was not at the center of the Milky Way.
E) His telescope revealed the four moons of Jupiter, a model solar system.
Answer: C
Diff: 2 *Page Ref: 2.3*

11) Which of these was NOT a part of the original Copernican model?
A) The Sun lies at the center of the solar system.
B) Mercury must move faster in its orbit than any other planet.
C) The Earth rotates on its axis once a day.
D) Venus can go all the way around the Sun.
E) Mercury speeds up at perihelion, and slows down at aphelion.
Answer: E
Diff: 3 *Page Ref: 2.3*

12) Which of the statements below is part of both the Ptolemaic and Copernican models?
A) The Earth orbits the Sun once a year.
B) The Sun lies in the center of the Cosmos.
C) The Moon orbits the Earth once a month.
D) Epicycles are needed to explain retrograde motion of the planets.
E) Venus' epicycle must always lie between us and the Sun.
Answer: C
Diff: 3 *Page Ref: 2.3*

13) Which of these was NOT seen telescopically by Galileo?
A) sunspots
B) Venus' phase cycle
C) Four moons around Jupiter
D) stellar parallax
E) Craters and mare on the Moon
Answer: D
Diff: 1 *Page Ref: 2.4*

14) Which of the following was NOT a contribution of Galileo to astronomy?
A) Sunspots showed the Sun was rotating on its axis, like the Earth does.
B) The four moons of Jupiter are a model for the solar system motions in general.
C) The phases of Venus prove it orbits completely around the Sun.
D) The changing appearance of Saturn's rings corresponds to our seasons.
E) The craters and mare of the Moon prove it a world in its own right.
Answer: D
Diff: 2 *Page Ref: 2.4*

15) Which of the following is a contribution to astronomy made by Galileo?
A) The astronomical telescope can show us far more detail than the eye can.
B) Jupiter has four moons orbiting it.
C) The Moon has craters, mountain, valleys, and dark flat areas on its surface.
D) Venus appears almost fully lit when it lies on the far side of the Sun.
E) all of the above
Answer: E
Diff: 2 *Page Ref: 2.4*

16) Which of these observations of Galileo refuted Ptolemy's epicycles?
A) the complete cycle of Venus' phases
B) the rotation of sunspots across the sun's surface
C) the revolution of Jupiter's moons around it
D) the craters on the Moon
E) the visibility of many more stars with the telescope
Answer: A
Diff: 2 *Page Ref: 2.4*

17) Which of these was NOT a telescopic discovery of Galileo?
A) the moons of Saturn
B) the craters and mare of the Moon
C) sunspots and the rotation of the Sun
D) the four largest moons of Jupiter
E) the phases of Venus
Answer: A
Diff: 2 *Page Ref: 2.4*

18) A fatal flaw with Ptolemy's model is its inability to predict the observed phases of
A) the Sun during an eclipse.
B) the Moon in its monthly cycle.
C) Mercury and Venus.
D) Mars and Jupiter.
E) Jupiter and Saturn.
Answer: C
Diff: 2 *Page Ref: 2.4*

19) It took two centuries for the Copernican model to replaced the Ptolemaic model because
A) in Copernicus' time, there were no telescopes.
B) the Church wouldn't let anyone talk about Copernicus' model for 200 years.
C) there was no scientific evidence to support either model until Galileo made his observations.
D) the Ptolemaic model was simpler and more aesthetically pleasing.
E) the Copernican model required complicated new terms to explain it correctly.
Answer: C
Diff: 3 *Page Ref: 2.4*

20) Galileo found the rotation period of the Sun was approximately
A) a day.
B) a week.
C) a month.
D) three months.
E) a year.
Answer: C
Diff: 3 *Page Ref: 2.4*

21) Kepler's first law worked, where Copernicus' original heliocentric model failed, because Kepler described the orbits as
A) elliptical, not circular.
B) much larger than Copernicus had envisioned.
C) around the Sun, not the earth.
D) being on equants instead of epicycles.
E) complex, with epicycles to account for retrograde motions.
Answer: A
Diff: 1 *Page Ref: 2.5*

22) Tycho Brahe's contribution to Kepler's Laws of Planetary Motion were
A) his detailed and accurate observations of the planet's position.
B) his observations of Jupiter's moons.
C) a mathematical explanation of epicycles.
D) a precise lunar calendar.
E) the correct explanation of lunar phases.
Answer: A
Diff: 1 *Page Ref: 2.5*

23) The most famous prehistoric astronomical observatory is:
A) the Sphinx.
B) Stonehenge.
C) Big Horn stone circle.
D) Carcacol.
E) Mount Rushmore.
Answer: B
Diff: 1 *Page Ref: 2.5*

24) A circular orbit would have an eccentricity of
A) 0.
B) between 0 and 0.5.
C) between 0.5 and 1.
D) exactly 1.0.
E) infinity.
Answer: A
Diff: 1 *Page Ref: 2.5*

25) Upon which point do Copernicus and Kepler disagree?
A) The Moon orbits the Earth.
B) The Earth orbits the Sun.
C) Retrograde motion occurs when one planet overtakes another.
D) The orbits of the planets are ellipses, with one focus at the Sun.
E) Venus will appear as a crescent when she retrogrades between us and the Sun.
Answer: D
Diff: 2 *Page Ref: 2.5*

26) What contribution to astronomy was made by Tycho Brahe?
A) The planets' orbits around the Sun are ellipses, not circles.
B) The Earth is not the center of the Universe.
C) His observations of planetary motion with great accuracy proved circular orbits could not work.
D) His telescope revealed the moons of Jupiter before Galileo noted them.
E) Retrograde motion must be explained by epicycles larger than those of Ptolemy.
Answer: C
Diff: 2 *Page Ref: 2.5*

27) Which concept was NOT a part of Kepler's Laws of Planetary Motion?
A) All planetary orbits are ellipses.
B) The square of the planet's period is equal to the cube of its average distance.
C) A planet must move fastest in its orbit at perihelion.
D) Epicycles are needed to explain the varying brightnesses of the planets.
E) The line that connects the Sun to Mercury sweeps out the same area in a month as does the line connecting us to the Sun.
Answer: D
Diff: 2 *Page Ref: 2.5*

28) According to Kepler's third law, the square of the planet's period in years is:
A) equal to its perihelion distance from the Sun in A.U.
B) inversely proportional to its mass in kilograms.
C) equal to the fourth power of its average temperature in degrees Kelvin.
D) proportional to the cube of its semimajor axis in A.U.
E) equal to the square of its aphelion distance in A.U.
Answer: D
Diff: 2 *Page Ref: 2.5*

29) What does Kepler's third law imply about planetary motion?
A) All planets orbit the Sun at the same speed.
B) Planets closer to the Sun orbit at a slower speed than planets further from the Sun.
C) Planets further from the Sun orbit at a slower speed than planets closer to the Sun.
D) Planets further from the Sun orbit at a faster speed than planets closer to the Sun.
E) This law implies nothing about a planet's motion.
Answer: C
Diff: 3 *Page Ref: 2.5*

30) A planet whose distance from the Sun is 3 A.U. would have an orbital period of how many Earth-years?
A) 3
B) $\sqrt{27}$
C) $\sqrt{3}$
D) 9
E) 81
Answer: B
Diff: 3 *Page Ref: 2.5*

31) The place in a planet's orbit that is closest to the Sun is called
A) vernal equinox
B) aphelion
C) perihelion
D) crossing the ecliptic.
E) None of these; a planet's distance from the Sun never changes.
Answer: C
Diff: 2 *Page Ref: More Prec. 2-1*

32) During the eighteenth and nineteenth centuries, attempts to precisely measure the astronomical unit relied largely on rare:
A) total solar eclipses.
B) transits of the inferior planets across the Sun.
C) passages of comets close to the Earth.
D) maximum elongations of Venus.
E) oppositions of Mars.
Answer: B
Diff: 2 *Page Ref: 2.6*

33) Today we rely largely on what technique to precisely measure distances in the solar system?
A) transits of Venus across the Sun
B) radar echo timings
C) measurement of stellar parallaxes.
D) timings of the eclipses of its moons by Jupiter's shadow
E) precise measurements of length of the year with atomic clocks
Answer: B
Diff: 2 *Page Ref: 2.6*

34) The force of gravity varies with the
A) product of the two masses.
B) inverse of the distance separating the two bodies.
C) inverse square of the distance separating the two bodies.
D) Both A and B are correct.
E) Both A and C are correct.
Answer: E
Diff: 1 *Page Ref: 2.7*

35) The Law of Universal Gravitation was developed by:
A) Kepler.
B) Galileo.
C) Newton.
D) Copernicus.
E) Einstein.
Answer: C
Diff: 1 *Page Ref: 2.7*

36) The force of gravity between two objects:
A) increases with the masses of the bodies, but decreases with their separations.
B) increases with the masses of the bodies, but decreases with the square of the distances between them.
C) increases with the square of their masses, but decreases with the cube of their periods of orbit about the Sun.
D) depends on the density, not the mass of the bodies.
E) depends on the temperature, density, and size of the bodies.
Answer: B
Diff: 1 *Page Ref: 2.7*

37) According to Newton's Law of Universal Gravitation, if the Moon were three times further from Earth, the force by Earth on the Moon would
A) increase by a factor of 3.
B) decrease by a factor of 3.
C) increase by a factor of 9.
D) decrease by a factor of 9.
E) stay the same.
Answer: D
Diff: 2 *Page Ref: 2.7*

38) How much stronger is the gravitational pull of the Sun on Earth, at 1 AU, than it is on Saturn at 10 AU?
A) 5X
B) 10X
C) 25X
D) 100X
E) 250X
Answer: D
Diff: 2 *Page Ref: 2.7*

39) Which of these was a contribution of Newton to astronomy?
A) Artificial satellites could be put into orbit about the Earth.
B) The Sun's gravity is greatest on a planet at perihelion, so the planet must speed up.
C) The Moon pulls as strongly on us as we do on it.
D) His differential calculus lets us calculate planetary motions more accurately.
E) All of these were due to Newton's work.
Answer: E
Diff: 2 *Page Ref: 2.7*

40) Geosynchronous satellites orbit at about four earth radii, where the earth's gravitational pull is:
A) 2 g.
B) 1 g.
C) 1/2 g.
D) 1/4 g.
E) 1/16 g.
Answer: E
Diff: 2 *Page Ref: 2.7*

41) Jupiter lies about 5 A.U. from the Sun, so at its distance:
A) the Sun's gravity is just as strong as it is here at Earth.
B) the Sun's gravity must be five times stronger to hold massive Jupiter in orbit.
C) the Sun's gravity is five times weaker there than at one A.U. distance.
D) the Sun's gravity is 25 times weaker than its pull on the Earth.
E) the Sun's gravity is so weak that ultimately Jupiter will escape the solar system.
Answer: D
Diff: 2 *Page Ref: 2.7*

42) How does Newton's Universal Law of Gravitation explain Kepler's laws?
A) Universal gravitation implies that the orbits of the planets must be elliptical (Kepler's first law).
B) Universal gravitation implies that the planets will sweep out equal areas in equal times (Kepler's second law).
C) Universal gravitation implies that the planets further from the Sun will move more slowly than the planets closer to the Sun (Kepler's third law).
D) Universal gravitation implies that when a planet is closer to the Sun in its orbit, it will move faster than when it is farther from the Sun (Kepler's second law).
E) Both C and D are correct.
Answer: E
Diff: 3 *Page Ref: 2.7*

43) Given that the planet orbiting the nearby star 51 Pegasi is about 20X larger than the Earth, but 400X more massive, on that world you would weigh:
A) the same as you do here.
B) twice as much as you do here.
C) half as much as you do here.
D) 20X more that you do here.
E) 400X more than you do here.
Answer: A
Diff: 3 *Page Ref: 2.7*

44) If the distance between two asteroids is doubled, the gravitational force they exert on each other will
A) also be doubled.
B) be half as great.
C) be one fourth as great.
D) will be 1/16 as great.
E) be four times greater.
Answer: C
Diff: 3 *Page Ref: 2.7*

45) Compared to orbital velocity, escape velocity is about:
A) the same.
B) 70% less.
C) 40% more.
D) twice as large.
E) four times greater.
Answer: C
Diff: 3 *Page Ref: 2.8*

46) Orbital speed is the speed with which a planet moves around the Sun. This speed is determined by
A) the mass of the planet only.
B) the mass of the Sun only.
C) both the mass of the planet and the mass of the Sun.
D) the mass of the planet and its distance from the Sun.
E) the mass of both the planet and the Sun and the distance between the two.
Answer: E
Diff: 3 *Page Ref: 2.8*

47) Escape velocity is the speed required to
A) orbit an object.
B) overcome the graviational pull of an object.
C) overtake an object in orbit and pass it.
D) keep from falling out of orbit around an object.
E) maintain a constant distance from an object.
Answer: B
Diff: 3 *Page Ref: 2.8*

48) According to Copernicus, retrograde motion for Venus must occur around
A) inferior conjunction, when it passes between us and the Sun.
B) quadrature, when the planet is 90 degrees away from the Sun.
C) greatest elongation, when the planet is farthest from the Sun.
D) superior conjunction, when the planet is on the far side of the Sun.
E) opposition, when the planet lies opposite the Sun in the sky.
Answer: A
Diff: 2 *Page Ref: More Prec. 2-3*

49) Combining Newton's and Kepler's laws, we can weigh the Sun, provided we know:
A) its density as found by spectroscopy.
B) its temperature as found by Wien's Law.
C) the size of the A.U. and exact length of the year.
D) the Earth's mass and circumference.
E) the exact timings of the transits of Venus and its diameter.
Answer: C
Diff: 3 *Page Ref: More Prec. 2-3*

50) Kepler's second law implies what about planetary motion?
A) A planet moves at a constant speed during its orbit of the Sun.
B) A planet moves faster when it is farther from the Sun.
C) A planet moves slower when it is closer to the Sun.
D) A planet moves faster when it is closer to the Sun.
E) This law implies nothing about a planet's motion.
Answer: D
Diff: 3 *Page Ref: More Prec. 2-3*

2.3 Fill-in-the-Blank

1) Astronomical alignments in antiquity on solstice and equinox sunrises and sunsets show us these builders had developed a _____ for farming.
Answer: calendar
Diff: 1 *Page Ref: 2.1*

2) Because he failed to observe stellar _____, Aristotle wrongly concluded we could not be in orbit around the Sun.
Answer: parallax
Diff: 1 *Page Ref: 2.2*

3) Galileo's discovery of four moons orbiting _____ provided new support for the ideas of Copernicus.
Answer: Jupiter
Diff: 2 *Page Ref: 2.4*

4) We are at _____ in January, when we are closest to the Sun in our elliptical orbit.
Answer: perihelion
Diff: 1 *Page Ref: 2.5*

5) While both Ptolemy and Copernicus assumed all orbits were _____, Kepler's first law corrected this and made planetary motion predictable.
Answer: circles
Diff: 1 *Page Ref: 2.5*

6) While the orbits of planets are nearly circular, the eccentricities of the orbits of _____ are near one.
Answer: comet
Diff: 2 *Page Ref: 2.5*

7) In the eighteenth and nineteenth centuries, the rare transits of _____ were critical in determining the astronomical unit's length.
Answer: Venus
Diff: 2 *Page Ref: 2.6*

8) According to Newton's second law, when the same force acts on two bodies, the body with the larger mass will have the _____ acceleration.
Answer: smaller
Diff: 1 *Page Ref: 2.7*

9) According to Newton, the gravity of the _____ is needed to explain planetary orbits.
Answer: Sun
Diff: 1 *Page Ref: 2.8*

10) Newton's modification of Kepler's Laws allows us to find the _____ of the planets, if we can observe satellites in orbit about them.
Answer: masses
Diff: 2 *Page Ref: 2.8*

2.4 Short Answer

1) How did Ptolemy explain the retrograde motion of Mars?
Answer: Mars will retrograde on the inner portion of its epicycle, when it is closest to us and its motion on the epicycle is more obvious than its motion along its deferent.
Diff: 3 *Page Ref: 2.2*

2) Explain how Copernicus would account for the retrograde loops of superior planets.
Answer: The Earth moves faster than these outer worlds, so at opposition we overtake them and as we sweep past them, they appear to retreat westward for a few weeks.
Diff: 2 *Page Ref: 2.3*

3) What did Galileo discover about Jupiter that supported Copernicus?
Answer: Its four moons were a model solar system, orbiting a larger central body just as the smaller planets orbit the Sun.
Diff: 2 *Page Ref: 2.4*

4) What did Galileo discover when looking at the Sun with his telescope, and how did this support Copernicus?
Answer: Sunspots, which rotated across the Sun's face, showing that the Sun was not perfect and it (and Earth) could rotate on its axis.
Diff: 3 *Page Ref: 2.4*

5) Of all his laws, Kepler was proudest of the third. Why was it so appealing in his search for cosmic harmony?
Answer: He found a simple math relation that directly connected the periods of revolution of each planet to its average distance from the Sun, so that $P^2 = D^3$.
Diff: 3 *Page Ref: 2.5*

6) Explain how the eccentricity describes the shape of an ellipse.
Answer: The higher the eccentricity, the more elongated the oval; a circle has an eccentricity of zero, while very stretched out comet orbits approach an eccentricity of one.
Diff: 3 *Page Ref: 2.5*

7) What is meant by the Astronomical Unit?
Answer: The Astronomical unit, or AU, is the mean distance between the Earth and Sun.
Diff: 2 *Page Ref: 2.6*

8) Using Newton's first law, describe the motion of a body is moving in the absence of any net external force.
Answer: in a straight line at constant speed forever
Diff: 2 *Page Ref: 2.7*

9) Explain how Newton could turn observations of a cannonball in flight into a satellite orbit.
Answer: Newton noted that the faster the ball was fired, the farther downrange it fell. He realized that if the speed were the orbital velocity of 18,000 mph, the ball would fall with a curvature that matched the Earth's, and remain in orbit.
Diff: 3 *Page Ref: 2.7*

10) Why do Newton's Laws show a force must be acting on the planets?
Answer: The planets are moving in elliptical orbits (not a straight line). According to First Law, if no force acts on the body, it must move in a straight line. Since the planets do not, there must be a force acting on them.
Diff: 3 *Page Ref: 2.7*

2.5 Essay

1) How would Ptolemy explain the rising of the Sun? Contrast this to Copernicus' explanation of the same event.
Answer: Ptolemy would say that the celestial sphere rotated westward, carrying the Sun over our eastern horizon. Copernicus said that we, the earth, rotate eastward once a day, and we turn to see the Sun on our eastern horizon at sunrise.
Diff: 3 *Page Ref: 2.3*

2) Of the Ptolemaic and Copernican models, who wins the battle of Occam's Razor for the simplest explanation of retrograde motions?
Answer: Copernicus simply had retrograde motion resulting from the different speeds of the planets, with retrograding occurring any time one planet overtook another. Ptolemy by contrast needed complex deferents, epicycles, and equants to handle the complex planetary motions.
Diff: 3 *Page Ref: 2.3*

3) How did Galileo's observations of Venus disprove the Ptolemaic model?
Answer: Ptolemy said that the epicycles for both Venus and Mercury were centered on the Earth-Sun line, so they must always lie between us and the Sun, so would always appear as crescents in the telescope. Galileo found Venus went through the entire phase cycle, proving that she revolved completely around the Sun, as predicted by Copernicus in his heliocentric model.
Diff: 2 *Page Ref: 2.4*

4) How does Kepler's First Law refine the Copernican model greatly?
Answer: Copernicus, like the Greeks, thought all orbits were circular. But when Kepler used elliptical orbits, particularly with Mars and Mercury, the theory fit the actual observations of planetary motion much better than did the old Ptolemaic one.
Diff: 2 *Page Ref: 2.5*

5) Relate Kepler's Second Law to the speeds of the planets.
Answer: In equal time intervals, the lines that connect each of the planets to the sun must all sweep out equal areas. The longer this line, the slower the planet could move and still sweep out this constant area. Thus more distant planets orbit the Sun slower, and each planet will speed up at perihelion and slow down at aphelion.
Diff: 3 *Page Ref: 2.5*

6) In what geometric way can we determine the absolute distances to the planets?
Answer: The parallax for some nearby planets can be directly measured, giving a precise knowledge of the A.U. This is now set from direct radar echo timings off the surface of the Sun and other planets.
Diff: 3 *Page Ref: 2.6*

7) Explain how Kepler's laws allow us to use the motion of an asteroid to find its average distance from the Sun.
Answer: By watching it long enough to find its period of revolution around the Sun, we can use Kepler's third law to get the average distance by squaring the period in years, then finding the cube root of this value for the average distance of the asteroid from the Sun in astronomical units.
Diff: 3 *Page Ref: 2.6*

8) According to Newton's third law, the Voyager probes pulled just as hard on Jupiter as it did on them when they flew past it. Why were they accelerated enough to leave the solar system but Jupiter still is in orbit about the Sun?
Answer: Jupiter was much more massive than the Voyagers, so by the second law, they slowed Jupiter down a tiny bit, but it accelerated the probes so much they escaped the gravity of the Sun itself.
Diff: 3 *Page Ref: 2.7*

9) What relationship did Newton find between orbital and escape velocities? Relate this to the staging of the Apollo missions, first to a parking orbit about the Earth, and then on to the Moon.
Answer: The escape velocity is greater than the orbital velocity by the square root of two. Thus the Apollo missions were first placed into Earth orbit, and from there an upper stage ignited to give them extra speed to break our gravitational hold.
Diff: 3 *Page Ref: 2.7*

10) How can astronomer's determine the mass of the Sun?
Answer: Using Newton's Laws, we know that gravity keeps the Earth in orbit around the Sun. Since the Earth's path is nearly circular, we can determine the size of the force keeping it on this path. Combining this equation (for centripetal force) with the gravity equation allows astronomers to calculate the Sun's mass.
Diff: 3 *Page Ref: 2.8, M.P. 2-3*